

CLAIM AMENDMENTS

Please amend the claims by amending claims 1, 4, 6-7, 9-10, 12, 14-16, 18-19, 22-26 and 28, to correct a spelling/grammatical error, as indicated on the following listing of all the claims in the present application after this Amendment:

1. (Currently Amended) A method for performing a finite element analysis comprising:
performing a ~~Eularian~~ Eulerian simulation, wherein a grid having nodes forming elements is superimposed with a material having a surface; and thereafter
projecting the nodes onto the surface of the material; and thereafter
mapping a set of solution variable fields to the material with an ~~Eularian~~ Eulerian mapping algorithm; and thereafter
performing a Lagrangian simulation.
2. (Original) The method of Claim 1, further comprising deleting empty elements and the nodes only connected to empty elements.
3. (Original) The method of Claim 1, wherein each element has a fill fraction, and wherein a node within the material surface is projected to the surface if the fill fraction is less than 0.7, and wherein a node without the material surface is projected to the surface if the fill fraction is in the range of about 0.5 to 0.8.
4. (Currently Amended) The method of Claim 1, wherein the ~~Eularian~~ Eulerian simulation is explicitly integrated and wherein the Lagrangian simulation is implicitly integrated.
5. (Currently Amended) The method of Claim 1, further comprising merging selected nodes together after ~~projected~~ projecting the nodes onto the surface.

6. (Currently Amended) An automated method of determining the final dimensions of a formed object comprising:

determining the dimensions of the object at first state after a forming operation with an explicit ~~Eularian~~ Eulerian based finite element simulation; and

determining the dimensions of the object at a final state after the forming operation by running an implicit Lagrangian based finite element simulation using the results of the ~~Eularian~~ Eulerian based simulation, the results comprising the dimensions at the first state.

7. (Currently Amended) The method of Claim 6, further comprising converting the results of the ~~Eularian~~ Eulerian simulation into a Lagrangian mesh before performing the Lagrangian simulation.

8. (Original) The method of Claim 7, wherein converting comprises projecting the nodes of the mesh onto a surface of the object.

9. (Currently Amended) An automated method of performing a finite element simulation comprising:

performing a first phase of the simulation using an ~~Eularian~~ Eulerian method to determine the dimensions of an object after an initial deformation, wherein an ~~Eularian~~ Eulerian element grid is formed;

mapping the solution from the ~~Eularian~~ Eulerian element grid of the first phase onto a Lagrangian element grid; and thereafter

performing a second phase of the simulation using a Lagrangian method to determine the dimensions after shrinkage or springback of the object from the initial deformation.

10. (Currently Amended) The method of Claim 9, wherein the ~~Eularian~~ Eulerian element grid is mapped to the Lagrangian element grid using ~~Eularian~~ Eulerian mapping algorithms.

11. (Original) The method of Claim 10, further comprising:

projecting nodes adjacent to the surface of the object to the surface of the object;
and
merging certain of the nodes together.

12. (Currently Amended) A computer readable storage medium storing one or more computer programs for performing a finite element simulation of a material, the computer programs comprising instructions for automatically switching from a ~~Eularian~~ Eulerian simulation of an initial deformation to a Lagrangian simulation of a subsequent deformation during the finite element simulation.

13. (Original) The computer readable storage medium of Claim 12, wherein the subsequent deformation is a springback type deformation resulting from residual energy within the material.

14. (Currently Amended) The computer readable storage medium of Claim 12, wherein the computer programs further comprise computer instructions for projecting nodes of the ~~Eularian~~ Eulerian simulation to the surfaces of the material.

15. (Currently Amended) The computer readable storage medium of Claim 14, wherein the computer programs further comprise computer instructions for automatically mapping the solution variable fields of the ~~Eularian~~ Eulerian simulation after projection of the nodes.

16. (Currently Amended) The computer readable storage medium of Claim 12, wherein the computer programs further comprise computer instructions for merging adjacent nodes of the ~~Eularian~~ Eulerian simulation.

17. (Original) The computer readable storage medium of Claim 14, wherein the computer instructions include instructions for projecting nodes of elements within the material to the surface if the element is less than 70 percent full, and for projecting nodes without the material to the surface if the element is 70 percent or more full.

18. (Currently Amended) A computer system comprising:
one or more computers; and
one or more computer programs running on the computer(s), the computer programs for performing a finite element simulation of a material comprising a first explicit ~~Eularian~~ Eulerian simulation step and a second implicit Lagrangian simulation step, the computer programs comprising computer instructions for automatically switching from the explicit ~~Eularian~~ Eulerian simulation step to the implicit Lagrangian simulation step during the finite element simulation.

19. (Currently Amended) The computer system of Claim 18, wherein the computer programs further comprise computer instructions for converting the grid and the solution variable fields formed during the first ~~Eularian~~ Eulerian step into a grid and solution variable fields for use in the second Lagrangian step.

20. (Original) The computer system of Claim 19, wherein the instructions for converting the grid and solution variable fields include instructions for projecting the nodes of elements of the grid onto a surface of the material.

21. (Original) The computer system of Claim 19, wherein the instructions for converting the grid include instructions for merging selected nodes together.

22. (Currently Amended) A data signal embodied in a carrier wave, the data signal including one or more computer programs for performing a finite element simulation, the computer programs comprising instructions for automatically switching between a ~~Eularian~~ Eulerian formulation and a Lagrangian formulation during the finite element simulation.

23. (Currently Amended) The data signal embodied in a carrier wave of Claim 22, wherein the computer programs further comprise computer instructions for beginning the finite element simulation using the ~~Eularian~~ Eulerian formulation.

24. (Currently Amended) The data signal embodied in a carrier wave of Claim 22, wherein the computer programs further comprise computer instructions for converting the results and mesh of the ~~Eularian~~ Eulerian formulation into results and mesh usable for the Lagrangian formulation.

25. (Currently Amended) A method for performing a finite element analysis, the method comprising automatically switching from an ~~Eularian~~ Eulerian formulation to a Lagrangian formulation during the analysis.

26. (Currently Amended) The method of Claim 25, wherein the ~~Eularian~~ Eulerian method is explicitly integrated and wherein the Lagrangian method is implicitly integrated.

27. (Original) The method of Claim 25, wherein the switching comprises projecting the nodes onto the surface of the material.

28. (Currently Amended) The method of Claim 27, further comprising mapping a set of solution variable fields to the material with an ~~Eularian~~ Eulerian mapping algorithm.

SPECIFICATION AMENDMENTS

Please amend the specification as follows to correct spelling/grammatical errors:

Page 9, line 24

A finite element analysis according to an embodiment of the invention is split into two phases. The ~~Eularian~~ Eulerian and Lagrangian phase can be implicit or explicit. For illustrative purposes an explicit ~~Eularian~~ Eulerian phase and an implicit Lagrangian phase are described. The explicit Eulerian phase is described by the flow diagram in Figure 5 and the implicit Lagrangian phase is described by the flow diagram in Figure 8.

Page 10, line 20

Referring once again to Fig. 5, in step E4, the system will check if the termination time, t_{max} , has been reached. If it has been reached, the process will continue on to step E6. If it has not been reached, the system will update the time, t , for a new time step increment in step E5, and continue on until time t_{max} has been reached. The time t_{max} is a the overall time allotted for a simulation or part of a simulation, and is user selectable. In this instance, it is the time at which the ~~Eularian~~ Eulerian portion of the simulation will terminate, i.e., when no more ~~Eularian~~ Eulerian time steps will be performed. When the user sets up the simulation, he will decide at which point in time he wishes to conclude the ~~Eularian~~ Eulerian portion of the simulation. Alternatively this may be preset in the software for certain simulations.

Page 12, line 10

Referring once again to Fig. 5, in step E9, closely spaced nodes are merged. Different nodes might be projected to almost the same point on the material surface, and some brick

(orthogonal ~~Eularian~~ Eulerian grid) elements degenerate to 4, 5, 6 or 7 node elements. Nodes located a small distance from each other are merged according to the following formula:

$$d < 0.2\sqrt[3]{V} \Rightarrow \text{merge nodes},$$

where d is the distance between two adjacent nodes in one element and V is the element volume.

Page 14, line 7

An ~~Eularian~~ Eulerian simulation is first performed. The impact event is simulated dynamically with an explicit time integration for a short period of time, as seen in Figure 9. The first frame of Figure 9 captures the instant the falling box makes contact with the beam (time $t=0$). In the second and third frames, the beam has been deflected by the impact. The third frame shows the maximum deflection of the beam.

Page 15, line 18

Referring to Figure 13a, a thick cylindrical disk of material is to be formed into a cylindrical cup using a forging process. Figure 13a shows the disk material 300 inside a larger computational domain 305 which is initially void. The outline of the forging tool 310 is shown in each figure 13a - 13d. The bottom surface 310a of the forging tool 310, which may be the bottom of a piston in some applications moves down to force the material up through the side cavity 310b of the forging tool 310. Only one quarter of this axisymmetric model is shown. In this ~~Eularian~~ Eulerian phase of the simulation note that the grid and its elements are fixed and the material moves through the fixed grid.